Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

Recent improvements in decadal prediction

Francisco J. Doblas-Reyes

EUCP
European Climate Prediction system

ICREA

Typical climate change information

Global annual mean and Mediterranean land summer near-surface temperature.

M. Jury (BSC)
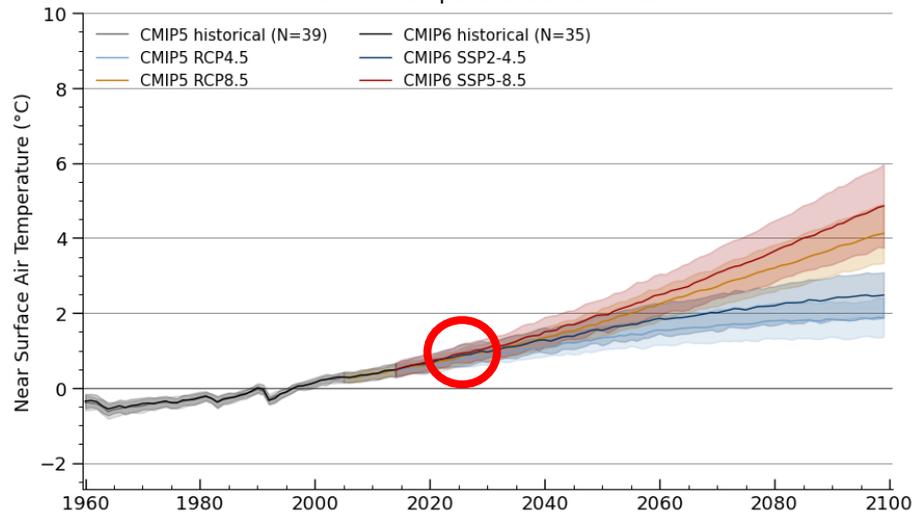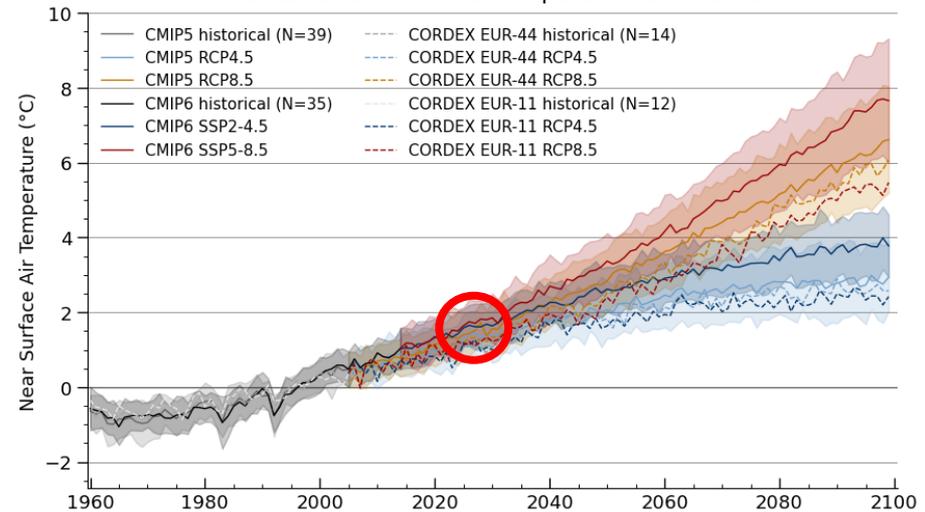
# An alternative: decadal climate predictions

The WMO-recognised global producing centres of decadal predictions contribute to multi-model predictions.

Probability of the most likely quintile category (masked where FairRPSS < 0) - pr - Multi-model-2 - Annual mean
Start date: 2018 - Forecast period: years 1-5 - Reference period: 1981-2010
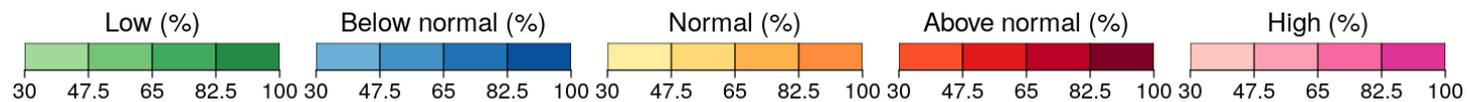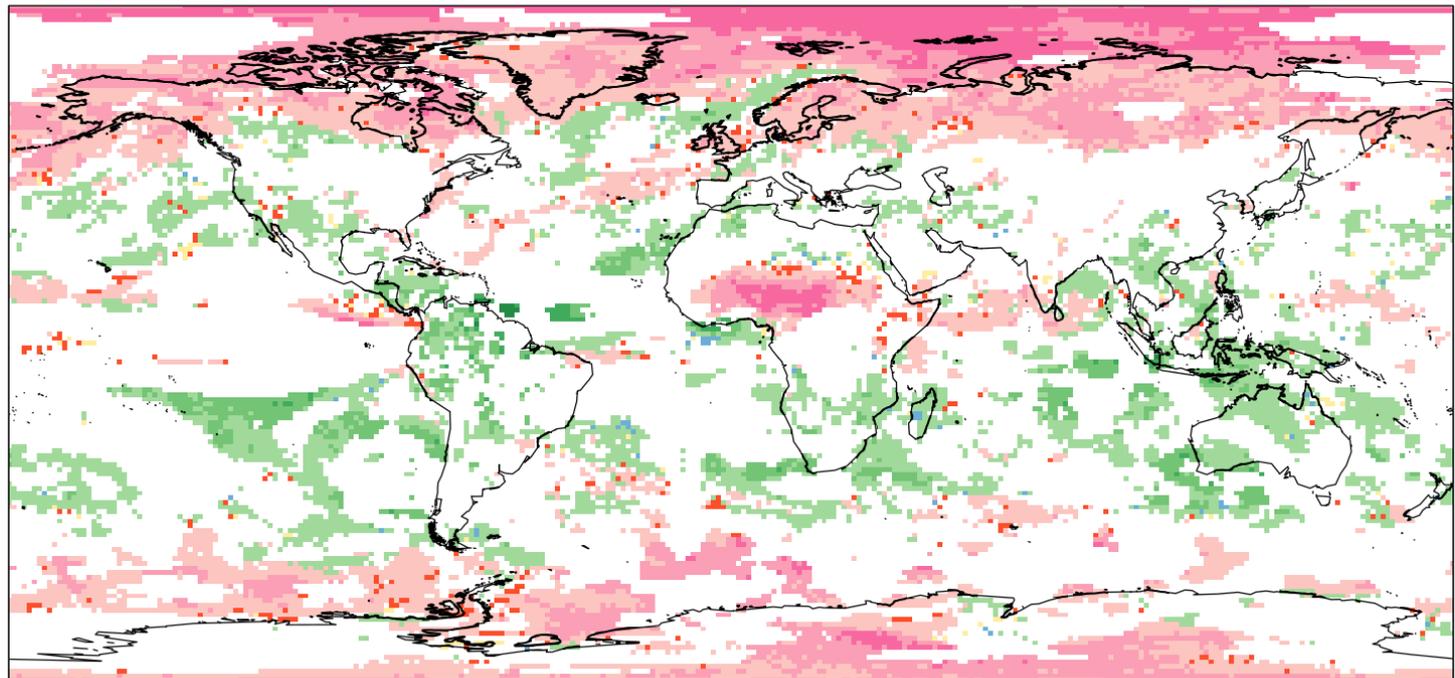
Why could we expect skill?

Skill of decadal predictions is highly sensitive to ensemble size due to the low signal-to-noise ratio (multi-model sea level pressure correlation with more than 100, left, and 10 members, right). Careful member selection (160 members) unveils untapped skill for northern European precipitation predictions for the next nine years (bottom).

Smith et al. (2020, Nature)

Operationalisation

**WMO Lead Centre for
Annual-to-Decadal Climate Prediction**

The Lead Centre for Annual-to-Decadal Climate Prediction
collects and provides hindcasts, forecasts and verification data
from a number of contributing centres worldwide.
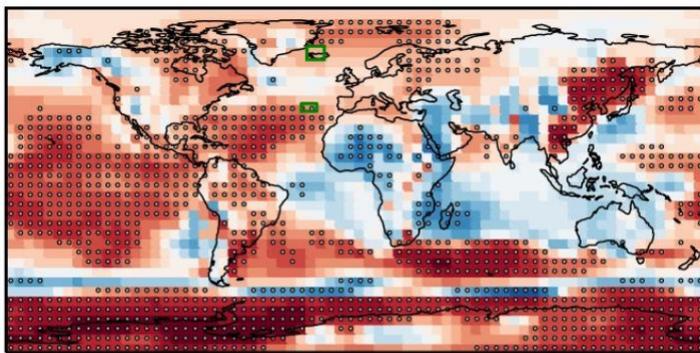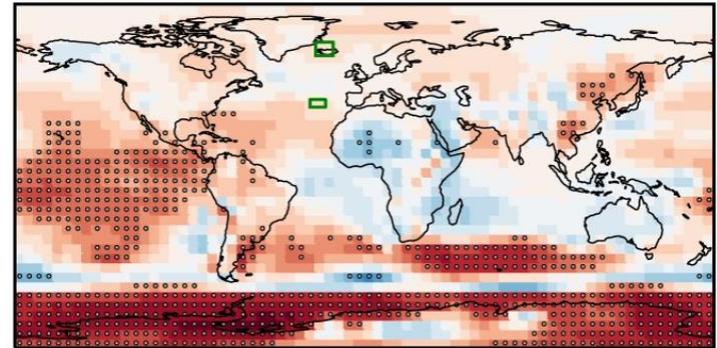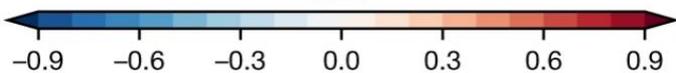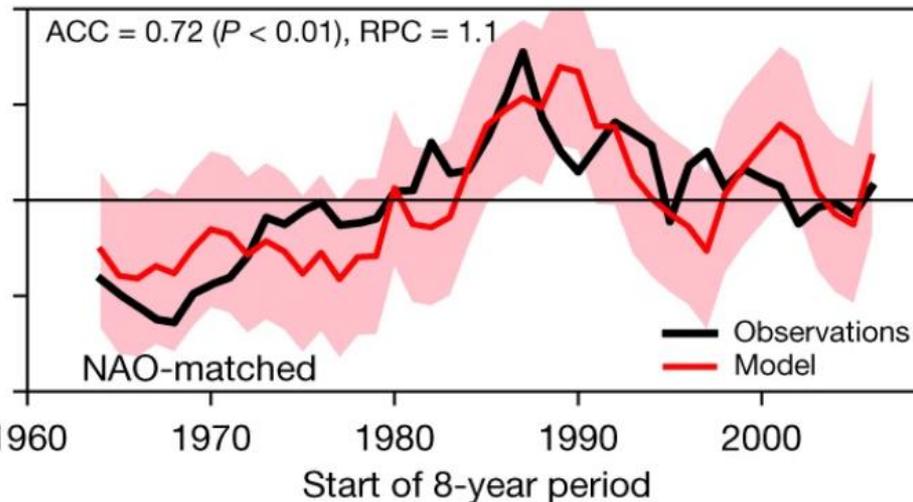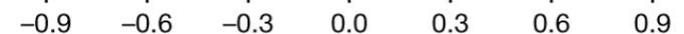
2018 predictions for 2019-2023 precipitation
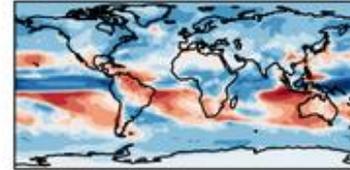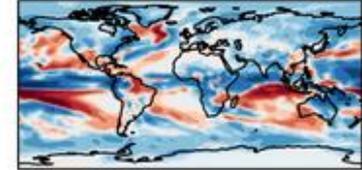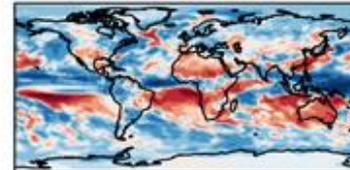
Average · BCCR · BSC · CCCMA · DWD · GFDL · MIROC · MOHC · MRI

-0.7 -0.4 -0.2 -0.1 -0.05 -0.02 0.0 0.02 0.05 0.1 0.2 0.4 0.7
mm/day

Standards and quality control

Vocabularies are part of the development of the evaluation and quality control (EQC) and a pre-requisite for the inclusion in the climate data store (CDS) of the Copernicus Climate Change Service.

Forecast time months 15-74 (years 2-5), lead time 1 year

Forecast time months 3-14 (year 1), lead time 0 years

Y   1 Nov   Y+1   Y+2   Y+3   Y+4   Y+5

Lagged mode

Forecast time months 15-74 (years 2-5), lead time 1 year

Forecast time months 3-14 (year 1), lead time 0 years

Y   Y+1   Y+2   Y+3   Y+4   Y+5

1 Nov
1 Oct
1 Sep
1 Aug
1 Jul

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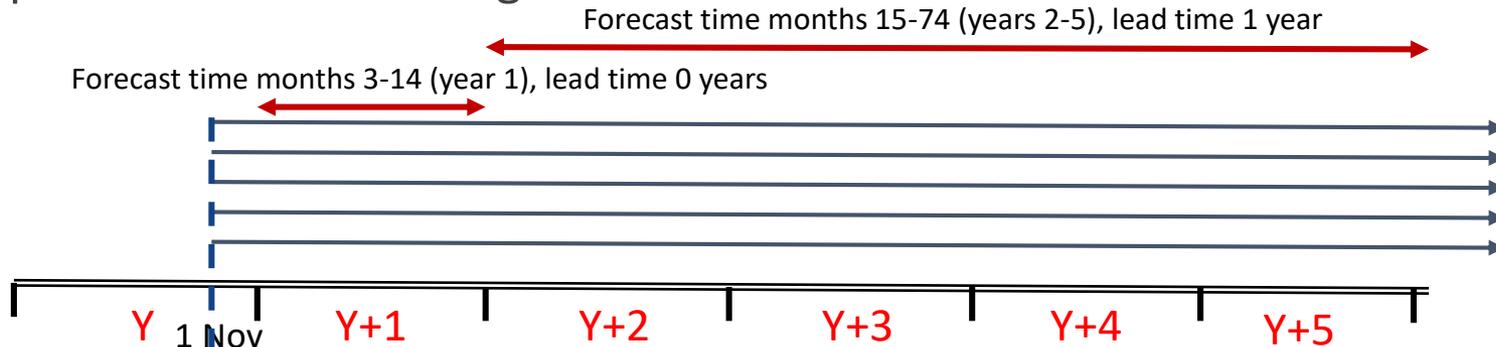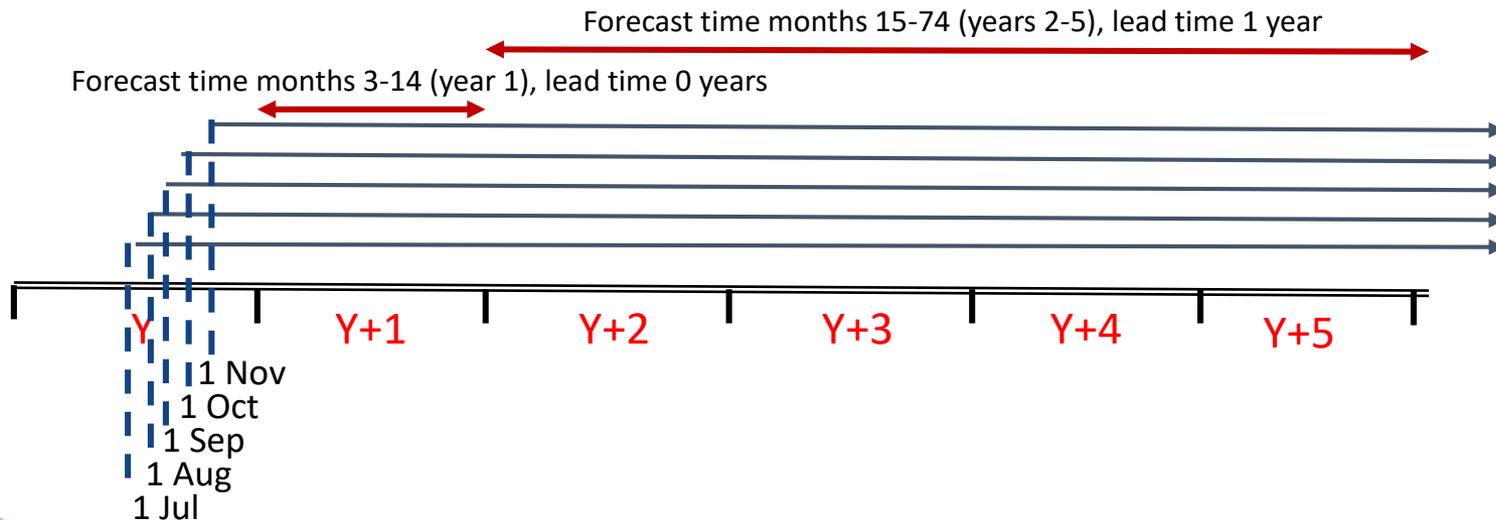
Emergency information: volcanic aerosols

The community has implemented protocols to produce timely climate information after an explosive volcanic eruption.

Multi-model global surface temperature change due to volcanic aerosols for the average of the Agung (1963), El Chichon (1982) and the Pinatubo (1991) eruptions.


Global Mean Surface Temperature

Hermanson et al. (2020, JGR)
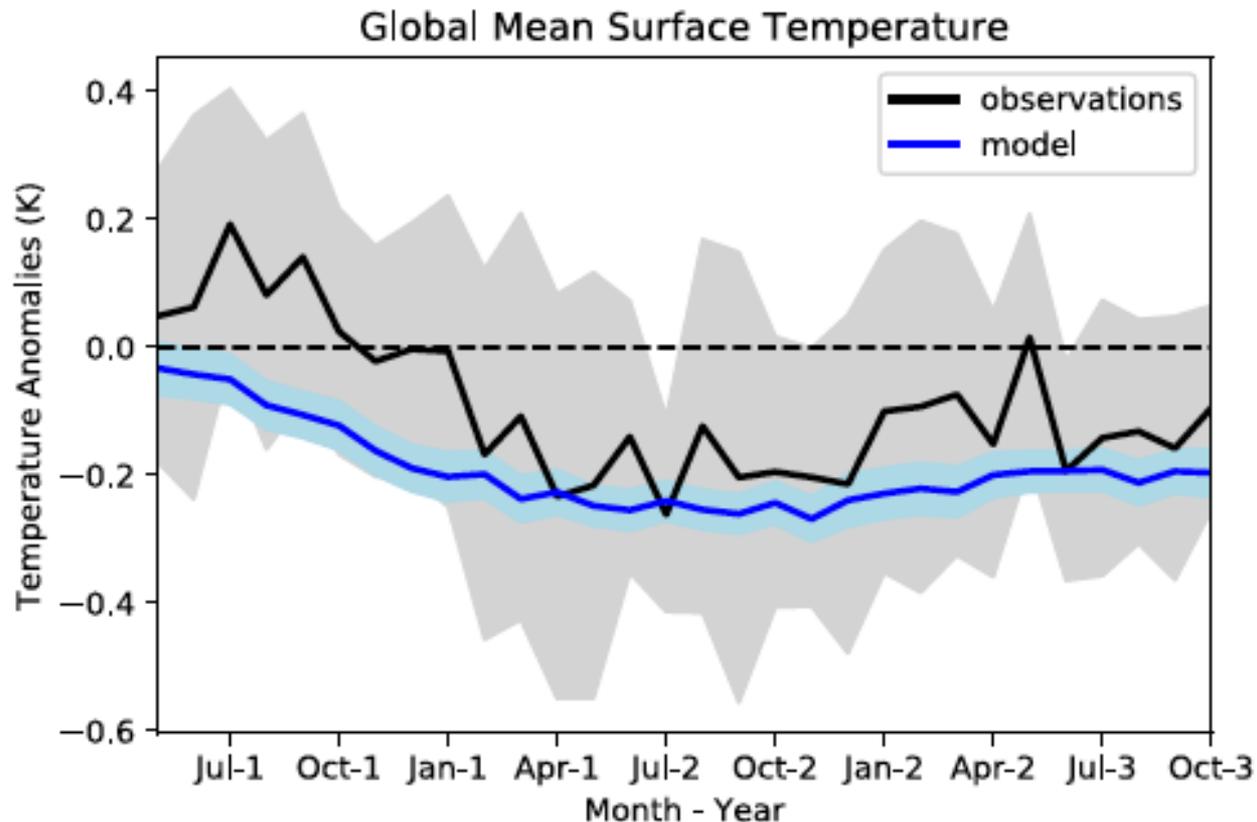
Applications of decadal climate predictions

Some of the WMO recognised global producing centres of decadal predictions contribute with the definition of standards for decadal predictions data and products, the evaluation of the European multi-model and the illustration of the decadal prediction use in the agricultural sector (in collaboration with JRC-Ispra).

SPEI6
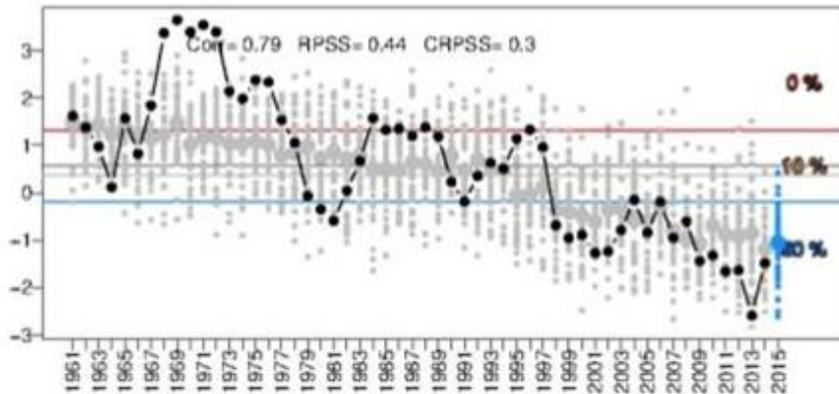
HMDI3
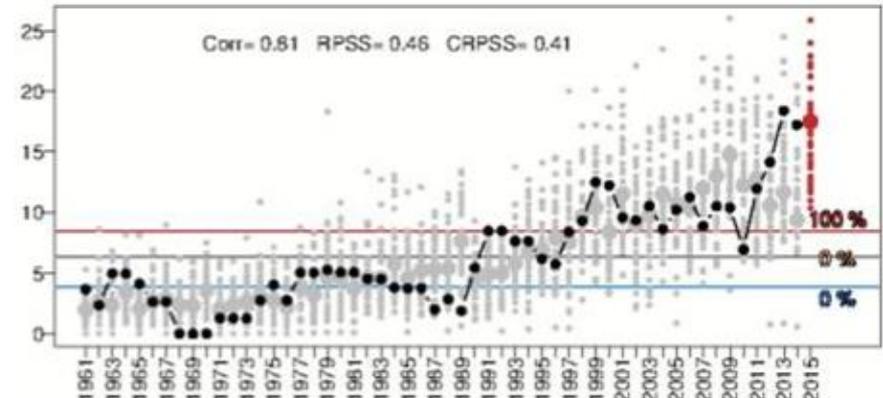
Indicators:

- Drought: Standardized Precipitation Evapotranspiration Index (SPEI6)
- Heat Stress: Heat Magnitude Day Index (HMDI3)

Wheat harvesting month
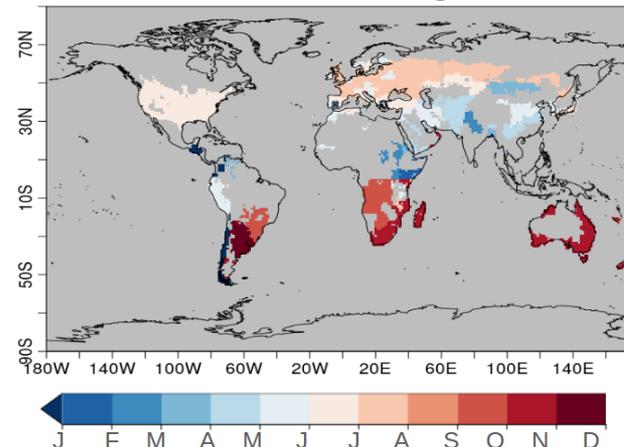
How to go beyond in decadal prediction?

From a user perspective (e.g. JRC) credibility and usability of decadal predictions are seriously compromised by current model quality (understood in the most general sense possible). Progress will not be possible without larger ensembles, higher resolution along with more realistic processes, better initialisation, etc.

Winter precipitation differences 2030-2050 and 1960-1980
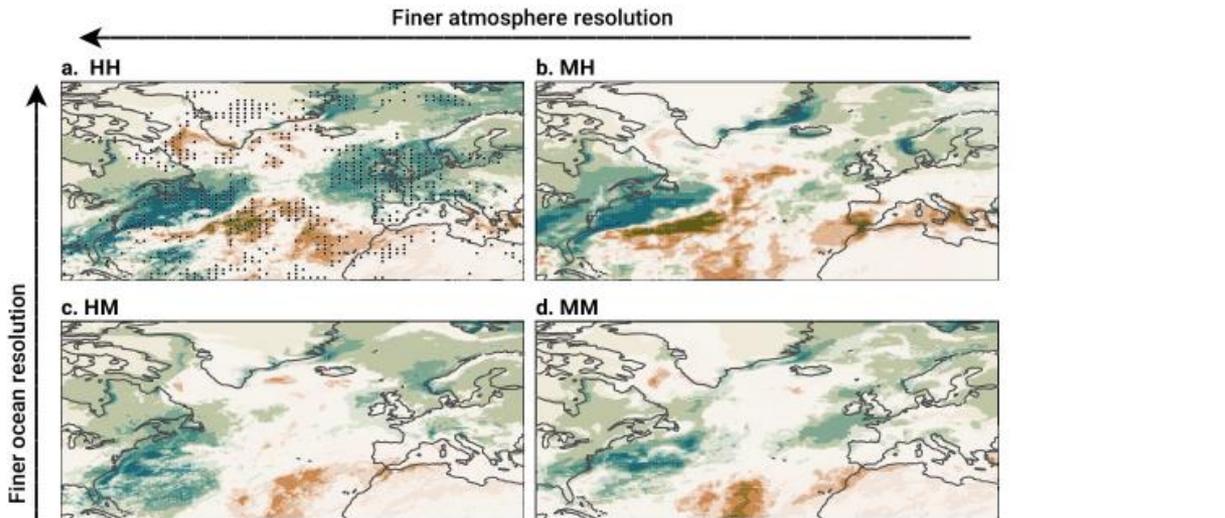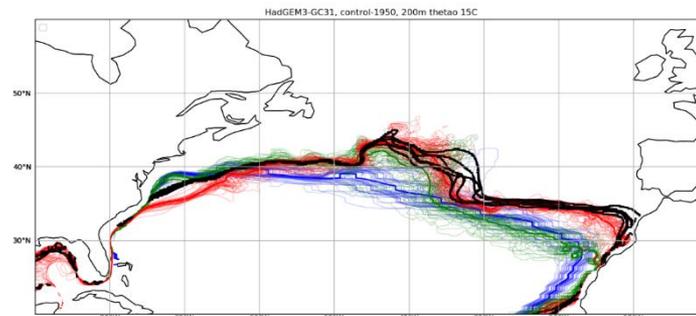
High-pass filtered wind stress divergence versus downwind SST gradients

Moreno-Chamorro et al., Grist et al., Tsartsali et al. (submitted)
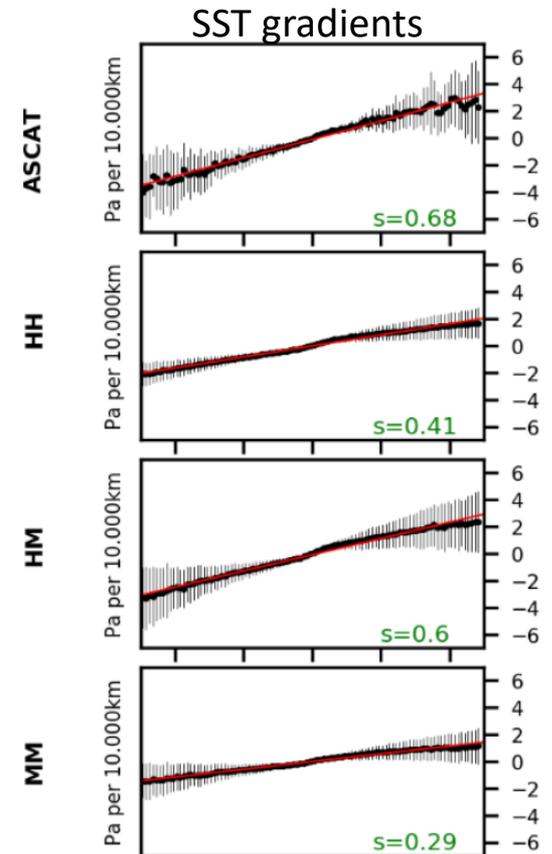
Carbon transfers can be fast

Skill of detrended CO2 flux in the ocean and land surface from several climate forecast systems. Significant skill increase with respect to projections marked with dots inside the circles.
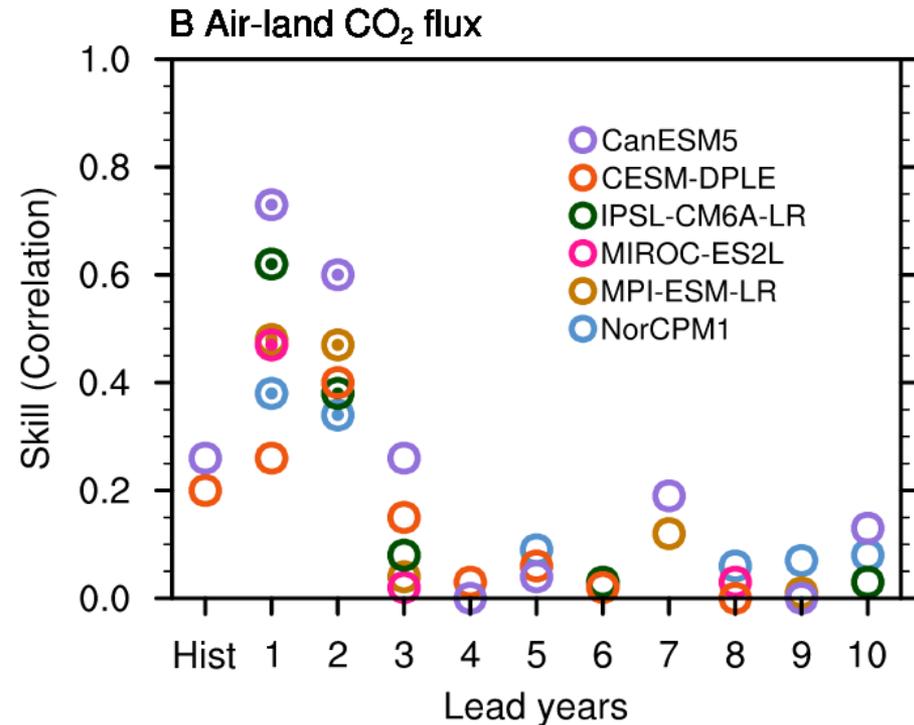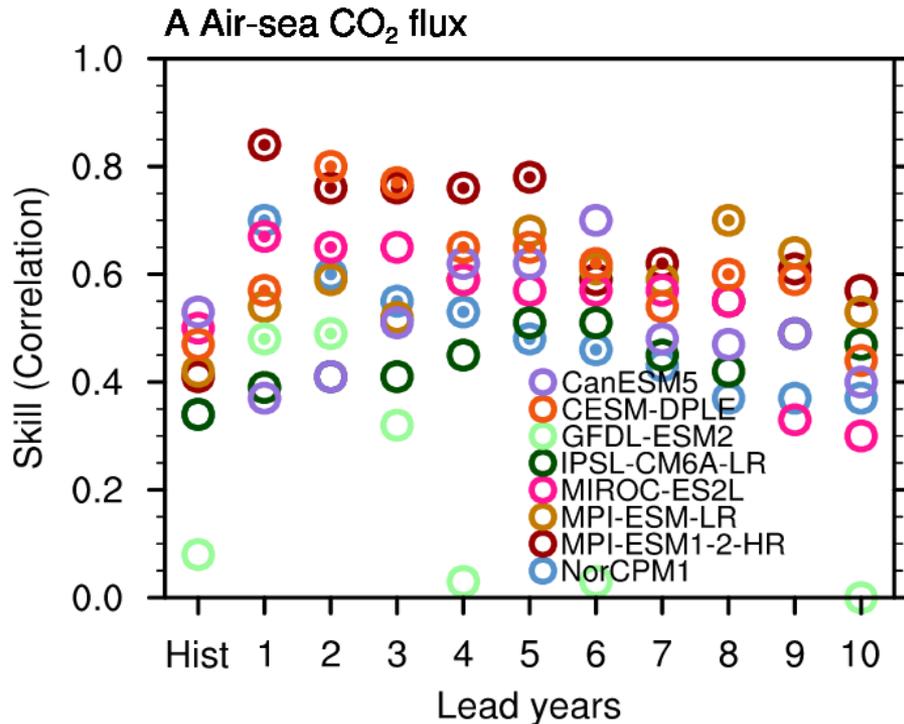
Going beyond 10 years

Decadal predictions can be used to constrain near-term climate projections. Constrained ensembles (35 members with the highest similarity to the decadal predictions) are compared to the unconstrained projections. The correlation for the constrained ensemble is higher at forecast times <10 years and similar afterwards while RMSE for the constrained ensemble is smaller for forecast times up to 15 years.
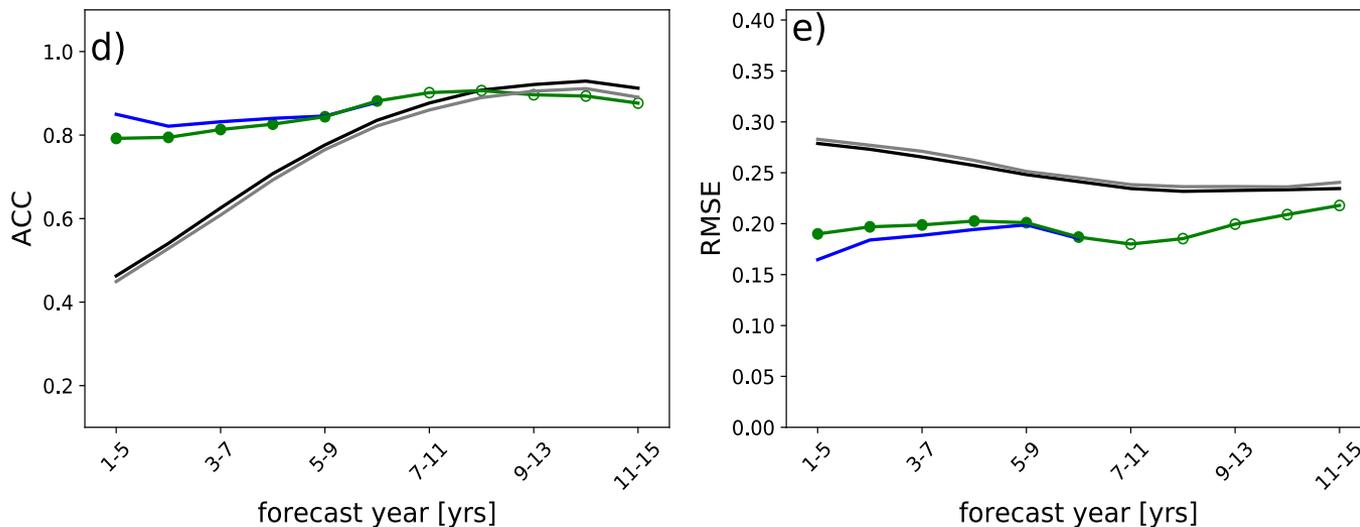
SST averaged over the North Atlantic subpolar gyre using CMIP5 simulations (predictions and projections.

Legend:
— uninitialized projections
— initialized predictions
— constrained projections
— uninitialized projections (n=35)

Recommendations

- Decadal climate predictions are regularly available, skilful, standards for users are being created, and offer a unique opportunity to address the Mission on Climate and European Green Deal objectives.
- Transfer to the emerging operational activities.

- Structural model error are two key limiting factors.
- Preliminary results suggest resolution and more realistic processes can increase climate forecast systems.
- Carbon fluxes are predictable at multiannual.
- Merging predictions and projections offers provide a new class of climate information for the near term.

Users need climate information on a range of time scales and different tools are required for an adequate response

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